***NOTE: this report follows from the "Report of a course given to university physics lecturers at the Civil Defence Staff College 8-11 July 1957" (UK National Archives doc. HO 228/21) which contains papers by Frank H. Pavry on blast data including height of burst effect curves, A. G. McDonald on the contribution of scattered thermal radiation (depending on the field of view of the sky), etc.***

# HOME OFFICE

## SCIENTIFIC ADVISERS' BRANCH

REPORT OF A CONFERENCE OF THE REGIONAL SCIENTIFIC ADVISERS FOR CIVIL DEFENCE, HELD AT THE CIVIL DEFENCE STAFF COLLEGE, SUNNINGDALE PARK, 12th to 14th MAY, 1959.

October, 1959.

CONFIDENTIAL

Report of a Conference of the Regional Scientific Advisers for Civil Defence, held at the Civil Defence Staff College, Sunningdale Park, 12th to 14th May, 1959.

The Conference was attended by Regional Scientific Advisers in England and Wales and Northern Ireland, by Regional Directors of Civil Defence and Officers of a number of Departments. The following were present for the whole or part of the proceedings:-

Scientific Advisers

| | |
|---|---|
| Professor G. E. Coates, M.A., D.Sc., F.R.I.C. | Northern Region |
| Professor W. Bradley, D.Sc., Ph.D., F.R.I.C. | North Eastern Region |
| Professor L. F. Bates, Ph.D., D.Sc., F.R.S. | North Midland Region |
| Professor D. D. Eley, M.Sc., Ph.D., Sc.D. | " " " |
| Professor L. Hunter, D.Sc., Ph.D., F.R.I.C. | " " " |
| B. C. Saunders, Esq., M.A., Sc.D., D.Sc. | Eastern Region |
| Sir Charles Ellis, B.A., Ph.D., F.R.S. | London Region |
| Emlyn Williams, Esq., B.Sc., Ph.D., F.R.I.C. | " " |
| G. E. Watts, Esq., M.A., Ph.D., B.Sc., F.R.I.C. | South Eastern Region |
| N. Pentland, Esq., M.Sc., Ph.D., F.Inst.P. | " " " |
| E. G. Cowley, Esq., M.Sc., Ph.D., F.R.I.C. | " " " |
| H. W. Thompson, Esq., C.B.E., M.A., D.Sc., F.R.S. | Southern Region |
| Professor W. E. Garner, C.B.E., D.Sc., F.R.S. | South Western Region |
| Professor F. C. Frank, O.B.E., D.Phil., F.R.S. | " " " |
| J. W. Cook, Esq., D.Sc., Ph.D., Sc.D., F.R.S. | " " " |
| Professor G. K. Conn, M.A., Ph.D. | " " " |
| Professor F. Llewellyn Jones, M.A., D.Phil., D.Sc. | Wales |
| S. T. Bowden, Esq., D.Sc., F.R.I.C. | " |
| Professor M. Stacey, D.Sc., Ph.D., F.R.S. | Midland Region |
| Professor P. B. Moon, M.A., Ph.D., F.R.S. | " " |
| Professor J. R. Squire, M.A., M.D., F.R.C.P. | " " |
| A. F. H. Ward, Esq., M.A., Ph.D., F.R.I.C. | North Western Region |
| Professor J. Diamond, M.Sc., Wh.Sc., M.I.Mech.E. | " " " |
| Professor K. G. Emeleus, M.A., Ph.D. | Northern Ireland |
| Professor H. B. Henbest, B.Sc., Ph.D., D.I.C. | " " |

Regional Directors

| | |
|---|---|
| Major General S. Lamplugh, C.B., C.B.E. | Northern Region |
| J. R. S. Watson, Esq., | North Eastern Region |
| Rear Admiral A. D. Torlesse, C.B., D.S.O., | North Midland Region |
| Rear Admiral W. L. G. Adams, C.B., O.B.E., | Southern Region |
| Major General J. S. Lethbridge, C.B., C.B.E., M.C. | South Western Region |
| Major General R. B. B. B. Cooke, C.B., C.B.E., D.S.O. | Wales |
| Air Marshal Sir Lawrence Pendred, K.B.E., C.B., D.F.C. | Midland Region |
| Lt. General E. N. Goddard, C.B., C.I.E., C.B.E., M.V.O. M.C. | North Western Region |
| Lt. General Sir Alexander Cameron, K.B.E., C.B., M.C. | South Eastern Region |
| Captain K. L. Harkness, D.S.C., R.N. | London Region |

Home Office

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R. H. F. Firth, Esq.
M. G. Russell, Esq.
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Air Commodore C. J. Luce, D.S.O.
Surgeon Captain J. G. Holmes, O.B.E., M.A., M.D., R.N.(Retd.)
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Miss I. M. Gibson

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Sir Owen Wansbrough-Jones, K.B.E., C.B., M.A., Ph.D.

Ministry of Agriculture, Fisheries and Food

A. C. Sparks, Esq.
J. G. Carnochan, Esq.
G. Wortley, Esq., M.A., B.Sc.
Brigadier J. A. Mullington, O.B.E.

Ministry of Health

D. Thomson, Esq., M.D., D.P.H.
L. H. Murray, Esq., O.B.E., M.D., D.P.H.

Air Ministry

E. A. Lovell, Esq., O.B.E., B.Sc., A.Inst.P.

Admiralty

V. H. Taylor, Esq., B.Sc., A.Inst.P.

Ministry of Home Affairs, Northern Ireland

Captain C. C. McCreight, M.B.E.

Home Office, Scientific Advisers' Branch

R. H. Purcell, Esq., C.B., Ph.D., D.I.C., F.R.I.C.
E. Leader-Williams, Esq., B.Sc., A.M.Inst.C.E.
G. R. Stanbury, Esq., B.Sc., A.R.C.S., F.Inst.P.
D. T. Jones, Esq., M.A., B.Sc., F.S.S.
J. McAulay, Esq., D.Sc., A.R.T.C., A.R.I.C.
A. G. McDonald, Esq., B.Sc., A.R.C.S.
T. Martin, Esq., M.Sc., D.I.C., F.Inst.P.
A. M. Western, Esq., M.A., B.Sc.
A. D. Perryman, Esq., B.Sc.
E. Hutchings, Esq.
Miss H. Duddy

## PROGRAMME OF THE CONFERENCE

Tuesday, 12th May

| | | |
|---|---|---|
| | Conference Assembles | |
| 20.30 | Introduction by the Under Secretary of State | Sir Charles Cunningham |
| | Science and Defence, past, present and future | Sir O. Wansbrough-Jones |

Wednesday, 13th May

| | | |
|---|---|---|
| 09.30 | Welcome by the Commandant | Major General F. R. G. Matthews |
| 09.35 | Opening Address by the Chief Scientific Adviser | Dr. R. H. Purcell |
| 09.45-11.00 | Working Party on the Operation of Scientific Teams at Region and Below. | |
| | (i) Introduction of the First Report on Operations at Regional level. | Dr. R. H. Purcell |
| | (ii) Discussion of the Report by Regional Scientific Advisers and Regional Directors. | |
| 11.00-11.20 | COFFEE | |
| 11.20-12.20 | Part III Training of Scientific Intelligence Officers | |
| | (i) Regional Courses and Exercises based on the Easingwold Course. | Mr. T. Martin |
| | (ii) Local Authority Exercises, Exercise "Arc". | Mr. E. Leader-Williams |
| 12.20-12.45 | Summing up of the morning's proceedings by the Director General | General Sir Sidney Kirkman |
| | LUNCH | |
| 14.15-14.35 | Radiation Tolerance Doses in Civil Defence. Position reached since the last Conference | Mr. G. R. Stanbury |
| 14.35-15.15 | Deployment of Civil Defence Forces in relation to Radio-activity. | Mr. E. Leader-Williams |
| 15.15-15.45 | The Operational Implications of Serial 8 | Mr. K. P. Witney |
| 15.45-16.15 | TEA | |

Wednesday, 13th May (contd.)

| | | | |
|---|---|---|---|
| 16.15-<br>17.10 | | Study "Pikadon". Presentation of the position at Sub-Region at H + 2 and H + 4 following a ½ M.T. bomb on Newcastle. | Staff College |
| 17.10-<br>17.45 | | Discussion of Serials 7 - 10. | Mr. G. R. Stanbury to open |

Thursday, 14th May

Scientific aspects of the Problem of living in an area contaminated by Radio-active Fall-Out.

| | | | |
|---|---|---|---|
| 09.30-<br>10.00 | (i) | Survey of Protection against Fall-Out afforded by Houses and other Buildings. | Mr. D. T. Jones |
| 10.00-<br>10.30 | (ii) | Radio-active Decontamination. | Dr. J. McAulay |
| 10.30-<br>11.00 | (iii) | Discussion on Serials 12 and 13. | |
| 11.00-11.30 | | COFFEE | |
| 11.30-<br>12.15 | (iv) | Food and Agriculture | Mr. G. Wortley |
| 12.15-<br>12.45 | (v) | Food Monitoring | Brigadier J. A. Mullington |
| | | LUNCH | |
| 14.15-<br>15.00 | (vi) | Discussion on Serials 15 and 16. | |
| 15.00-<br>15.45 | | Fire Problems after a Megaton Explosion Study "Torquemada". | Mr. G. R. Stanbury |
| 15.45-<br>16.00 | | Conclusion | |
| 16.00 | | TEA. Conference disperses. | |

wanting to go into the middle of a Z zone for the food there until considerably later, and it does look on a first analysis as though his tasks will develop im a fairly orderly way.

BRIGADIER MULLINGTON: I see him starting fairly early. The Regional Food Controller will be edging round to see where he can get food from for areas badly hit.

DR. PURCELL: Well I quite agree with that, but I am equally convinced that his movements will be limited by the public control conditions and the gradual clearance of the zones. Could I ask you to continue to turn this problem over in your minds and let me have any considered opinions that you may have by correspondence; that is the best conclusion for this afternoon.

III MR. STANBURY gave a talk on Study Torquemada, dealing with Fire Problems after a Megaton Explosion. He has provided the following summary:-

I. Estimation of initial fire incidence

The method used is based on that described in the Report of the Technical and Tactical Study Courses held at the Fire Service College in May, June and July 1952 entitled "The Fire Situation after an Atomic Attack on a British City" - a copy of which can be made available on application.

The British city concerned in these particular study courses was Birmingham and for this purpose a 1 in 12 scale model was made by the Birmingham Fire Brigade covering a 25° sector of the area likely to be affected by the explosion of a nominal atomic bomb over the centre of the city. With this model the problem of shielding - which is all important in this connection - could be dealt with quite satisfactorily. A lamp was set up at the point of burst in relation to the model, and it could be seen immediately which windows were exposed and which were shielded. After that it was only a question of estimating the chances of the development of continuing fires in relation to the fire risk and size of the fire compartment concerned by the methods described in detail in the report.

In this study we were concerned with the much larger area of damage produced by a 1 MT explosion, and we had no model. We are forced therefore to use maps and the most detailed maps available were the Insurance Plans of Liverpool and Birkenhead prepared by Messrs. C. E. Goad Ltd., which were hired specially for the purpose. These are to the scale of 40 ft. to the inch and they give complete details about road widths, height of buildings, construction etc. In order to reduce the volume and tediousness of the work involved in using maps the method developed for the Birmingham model had to be substantially simplified.

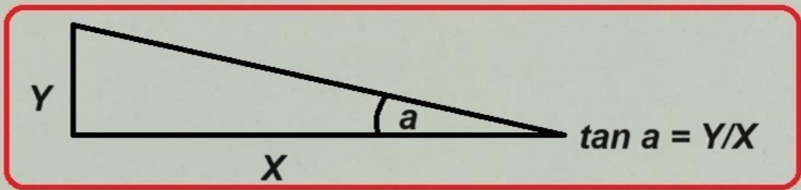
Effect of Shielding: Estimation of the Number of Exposed Floors

Assuming that buildings on opposite sides of a street which is receiving heat radiation from a direction perpendicular to its length are of the same height, then the number of exposed floors on the front of the buildings on the side of the road away from the explosion depends on

(a) the angle of arrival of the rays, say $\alpha$ and

(b) the width of the street = 10w

Where w = number of units of 10 ft.




If we take the average depth of a floor to be 10 ft. then the number of exposed floors is given by

$$\tan \alpha = \frac{10n}{10w} \qquad \text{or } n = w \tan \alpha$$

For a 1 MT groundburst bomb the height of the top of the fireball above ground is about 0.72 miles. Because this distance is large compared with the height of most buildings, the exposed upper floors do actually see a large part of the fire-ball and not just the top of it, but in assuming that the radiation is just as intense from the top as from the middle we are probably overestimating the fire situation which will result.

On the above basis the following table gives the number of exposed upper floors (to the nearest ½ floor) for a range of distances from the explosion and a range of street widths.

**Hence at 5 miles from 1 megaton ground burst, only top windows are exposed**

TABLE I

| Distance from explosion (miles) | Angle of arrival $\alpha^{o}$ | $\tan\alpha$ | Width of street (units of 10 ft.) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | 35 | .72 | 1.5 | 2 | 3 | 3.5 | 4.5 | 5 | 6 |
| 1½ | 26 | .48 | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 | 4 |
| 2 | 20 | .36 | .5 | 1 | 1.5 | 2 | 2 | 2.5 | 3 |
| 3 | 13½ | .24 | .5 | .5 | 1 | 1 | 1.5 | 1.5 | 2 |
| 4 | 10 | .18 | .5 | .5 | .5 | 1 | 1 | 1.5 | 1.5 |
| 5 | 8 | .15 | .5 | .5 | .5 | .5 | 1 | 1 | 1 |
| 6 | 7 | .12 | - | .5 | .5 | .5 | .5 | 1 | 1 |
| 7 | 6 | .1 | - | - | .5 | .5 | .5 | .5 | 1 |

It is obvious that for street widths greater than 80 ft. at close ranges (or for example where there is an open space in front of a building) it can be immediately assumed that all floors are exposed; since few buildings have more than 5 or 6 floors. At the extreme range for ignition the angle of arrival varies so slowly that for street widths greater than 80 ft. the number of exposed floors can always be taken as one. It is for these reasons that the Table is stopped at 80 ft.

To the numbers obtained from Table I must be added or subtracted the differences in numbers of floors of opposing buildings as shown on the maps to give the actual number of exposed floors in any particular case. This number of course cannot be negative, nor greater than the total number of floors in the building exposed.

Variation with Range

In the Birmingham study an attempt was made to allow for the variation in intensity of the radiation, with distance from the explosion on the chance of ignition, but the foundation for this was not very sound. In this study it was assumed -

(a) that there are no continuing fires inside a circle 1 mile in radius because of the complete collapse of all buildings

(b) that out to 1½ miles the only fires possible are those in buildings of steel framed or reinforced concrete construction

(c) that the chance of ignition is 100% all the way from 1½ miles to 5 miles, after which it drops to 30% for a further 2 miles. [At 7 miles from a 1 MT explosion the heat intensity is still 12 cal/sq.cm which is sufficient to ignite easily inflammable material like "Excelsior".]

Inclination of Streets to the Direct Line of the Heat Flash

The first two lines of the following table are taken from the Report already referred to.

TABLE II

| Angle between heat flash and street (degrees) | 90-75 | 75-60 | 60-45 | 45-30 | 30-15 | 15-0 |
|---|---|---|---|---|---|---|
| Proportion of heat flash entering windows % | 99 | 92.5 | 80 | 60 | 40 | 14 |
| Proposed grouping for Torquemada | 100% | | 80% | | Nil | |

For working with Goad Maps, the division into 6 angular groups is too cumbersome, and it was decided to use the 3 group system shown in the last line. This means that all streets inclined at an angle greater than 60° to the direction of the flash are assumed to be at right angles to it; all those between 30° and 60° have their chances of ignition reduced by 20%; and those below 30° are neglected. A small pilot study of one area showed that this approximation was very close, while the saving in work was considerable.

The chance of a continuing fire as affected by (a) Size of Fire Compartment and (b) Number of Windows.

This was dealt with in great detail in the earlier report, but considerable simplification was needed for use with the Goad maps.

The chance of a continuing fire developing from a small source of ignition decreases with the size of the fire compartment and increases with the number of sources of ignition i.e. with the number of exposed windows, and these were dealt with separately in the Birmingham model assessment. However, the decrease with size is roughly proportional to the area and the increase - because of windows - to the length (assuming an approximately square building). The overall effect is that the chance is inversely proportional to the length of the exposed front of the building.

In this study the chance has been still further reduced by two assumptions

(a) that 25% of the windows have been whitewashed and

(b) that 25% of the incipient fires are extinguished by fire guards giving an overall reduction of the chance of fire of 55% (75% x 75%).

Owing to the uncertainly connected with this part of the estimation there seemed to be no point in using more than 3 main fire compartment size groups and the figures finally adopted were as follows:-

Group (A) 20 ft. frontage. Chance 0.2

Group (B) 40 ft. " " 0.1

Group (C) 80 ft. " " 0.05

In the streets inclined between 60° to 30° to the heat flash, these chances were reduced by 20% to

| | |
|---|---|
| Group (A) | 0.16 |
| Group (B) | 0.08 |
| Group (C) | 0.04 |

The Method of Estimation

The following routine method was adopted for making use of the principles enumerated above.

1. For any particular sheet of the Goad maps, the distance of the centre of the street to ground zero was first estimated to the nearest mile.

2. From the N/S pointer on the sheet, the direction of the flash was determined and the streets perpendicular to this (within 30°) were noted.

3. Starting from one end of each street, each exposed fire compartment was considered in turn and the number of exposed floors marked on a tracing paper overlay, using Table I together with the information on the numbers of floors of opposite buildings given on the map.

4. All the fire compartments in Group (A) were then noted and the number of exposed floors for each was multiplied by the chance of a continuing fire developing (0.2 in this case) and the number recorded on the overlay in Green. The fire compartments in Group (B) were dealt with in a similar way and the number recorded on the overlay in Yellow. Finally the fire compartments in Group (C) were dealt with, and the chances recorded on the overlay in Red.

5. This process was repeated for the buildings in the streets inclined between 60° to 30° to the flash, but using the appropriately reduced chance figures.

6. All the figures in each of the colour groups were then added to give the total chance that continuing fires would be started on any one floor of any one building for each group of fire compartment sizes. Let us assume that these numbers are x, y and z. Then these numbers of fires were marked in on the overlay as red ticks, the actual choice of which building in each group being immaterial.

Inevitably there were many classes of buildings which did not respond readily to the above method of analysis, and each had to be considered on its merits, bringing into play as much wartime experience in this field as was available to the Branch.

Secondary fires

The problem of so-called "secondary" fires i.e. - those started as a result of disruption of some kind or another caused by the blast - was dealt with in great detail in a paper entitled "The Fire Risk from Blast Damage" which also appeared in the Fire Service College Report already referred to. This was based on a careful study of all the fly bomb records. It was found that about 6% of the bombs were responsible for large continuing fires and about 40% for small fires in debris most of which went out of their own accord. If we assume that one tenth of the small fires continue the overall figure for continuing fires is 10%. In a groundburst 20 KT bomb, the damage produced is equivalent to that of about 1,250 fly bombs. For a 1 MT groundburst the number would be -

$$1,250 \left(\frac{10^3}{20}\right)^{2/3} = 50,000$$

and if 10% of these cause fires, there will be 5,000 secondary fires.

It is not expected that this type of fire would occur beyond six miles since this is the limit of damage. Thus secondary fires might occur on the average at a ~~desnity~~ density of $\frac{5000}{\pi 6^2}$ = 40/sq. mile.

Each Goad Map covers an area of approximately 1/40th sq. mile so that on each map one extra fire must be included. Here again it is not important where fire is located, but it is reasonable to select a high fire risk occupancy such as paint ~~sotre~~ store, a furniture factory, or a garage.

## II. Estimation of Fire Spread

In the area of Liverpool and Birkenhead covered by the Goad Maps, the numbers of fires at H + 1 turned out to be as follows:-

| Fire Compartment Size | Number |
|---|---|
| Small | 1050 |
| Medium | 223 |
| Large | 20 |
| | 1293 |
| Secondary fires allocated in roughly the same proportion | 180 |
| | 1473 |

The area not covered by the Goad Maps was largely residential so that most of these additional fires were in the small compartment category.

The total number of fires was between 7,000 and 8,000, and it was decided to allocate the following round numbers to each category:-

| | |
|---|---|
| Small (S) | 7,000 |
| Medium (M) | 500 |
| Large (L) | 50 |
| Total (N) | 7,550 |

From last war experience of mass fire raids in Germany it was concluded that the overall spread factor was about 2; i.e. about twice as many buildings were destroyed by fire as were actually set alight by incendiary bombs; thus the assumptions adopted must allow for the final destruction by fire of about 15,000 buildings which is about 1 in 10 to 1 in 15 of all the buildings in the area.

For the purpose of assessing possible spread let us assume -

Proportion of fires in each category which burn out without spreading $= p_1$

Proportion of fires which spread to one other building $= p_2$

" " " " " " two " buildings $= p_3$

" " " " " " three " " $= p_4$

In each category $p_1 + p_2 + p_3 + 4 = 1$ and the final number of buildings destroyed by fire =

$$S(p_1 + 2p_2 + 3p_3 + 4p_4)s$$
$$+ M(p_1 + 2p_2 + 3p_3 + 4p_4)m + L(p_1 + 2p_2 + 3p_3 + 4p_4)l$$

As a first shot the following numbers are suggested:-

| | Fire Compartment Size | | |
|---|---|---|---|
| | Small | Medium | Large |
| $p_1$ | .6 | .25 | .1 |
| $p_2$ | .2 | .25 | .2 |
| $p_3$ | .1 | .25 | .3 |
| $p_4$ | .1 | .25 | .4 |

This gives:-

Final number of buildings destroyed by fire = (7,000 x 1.7) + (500 x 2.5) + (50 x 3.0) = 13,300 which is near enough for this purpose.

In order to estimate the number of fires burning at any given time it was necessary to make further assumptions about

(a) burn-out times and

(b) starting times for first, second and third spread fires.

The following are suggested:-

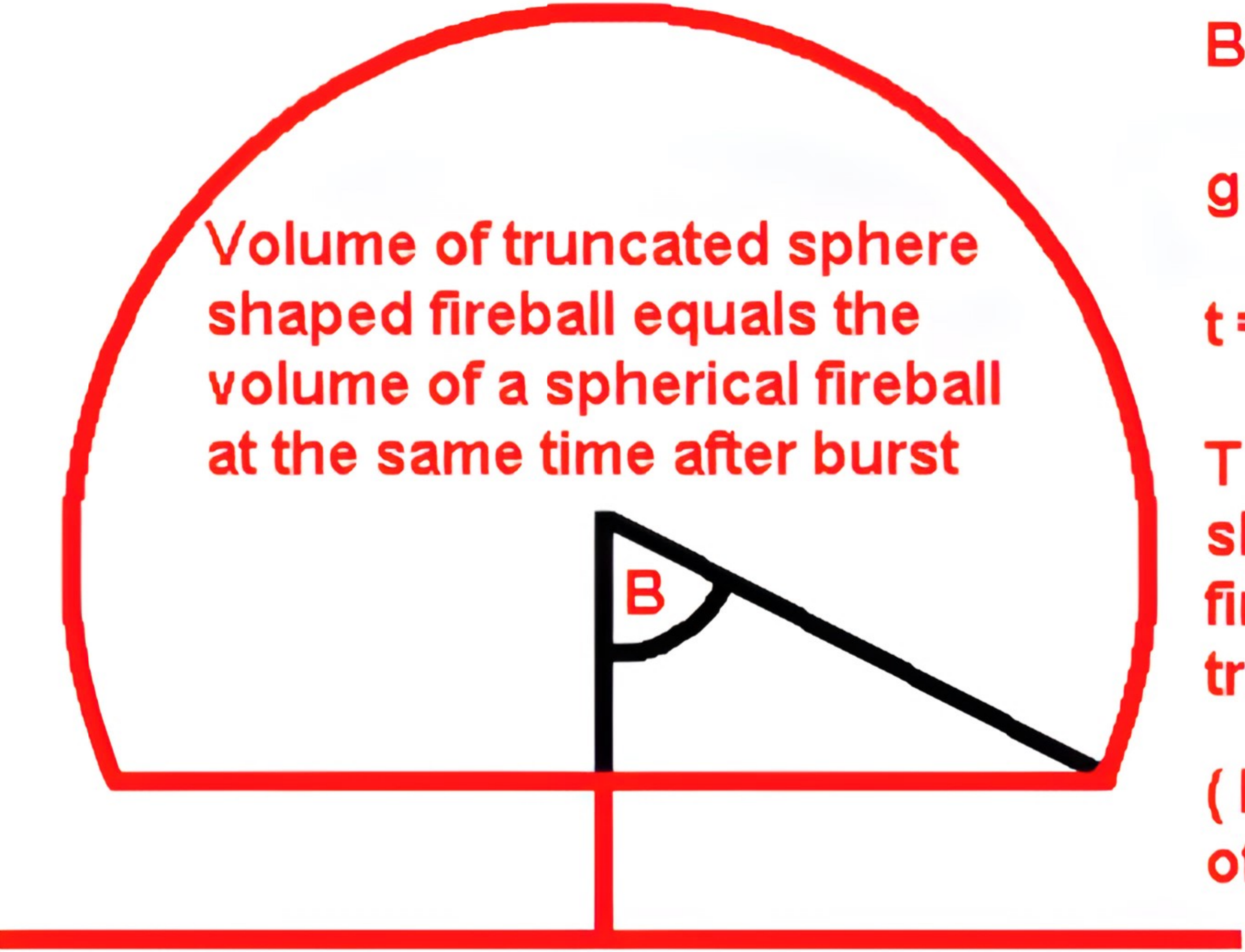
| | Fire Compartment Size | | |
|---|---|---|---|
| | Small | Medium | Large |
| Burn-out time from ignition (hours) | $1\frac{3}{4}$ | $3\frac{1}{2}$ | 7 |
| Starting time for | | | |
| 1st-spread fires | H + $1\frac{1}{2}$ | H + $1\frac{1}{2}$ | H + $1\frac{1}{2}$ |
| 2nd- " " | H + 3 | H + 3 | H + 3 |
| 3rd- " " | H + $4\frac{1}{2}$ | H + $4\frac{1}{2}$ | H + $4\frac{1}{2}$ |

These two sets of assumptions, combined with the actual numbers of fires in each category were then used to calculate the fire position at various times after H + 1 as follows:-

| Time After Burst (hours) | Origination of Fire | Fire Compartment Size | | | | | |
|---|---|---|---|---|---|---|---|
| | | Small | | Medium | | Large | |
| H + 1 | Initial heat flash + secondary fires | 7,000 | | 500 | | 50 | |
| H + 2 | Initial fires | Nil | 2,800 | 500 | 875 | 50 | 95 |
| | 1st spread fires (p2 + p3 + p4) | 2,800 | | 375 | | 45 | |
| | 2nd " " (p3 + p4) | Nil | | Nil | | Nil | |
| | 3rd " " (p4) | Nil | | Nil | | Nil | |
| H + 4 | Initial fires | Nil | 1,400 | Nil | 625 | 50 | 130 |
| | 1st spread fires (p2 + p3 + p4) | Nil | | 375 | | 45 | |
| | 2nd " " (p3 + p4) | 1,400 | | 250 | | 35 | |
| | 3rd " " (p4) | Nil | | Nil | | Nil | |
| H + 8 | Initial fires | Nil | Nil | Nil | 125 | Nil | 100 |
| | 1st apread fires (p2 + p3 + p4) | Nil | | Nil | | 45 | |
| | 2nd " " (p3 + p4) | Nil | | Nil | | 35 | |
| | 3rd " " (p4) | Nil | | 125 | | 20 | |

These numbers were divided between the various fire areas in the Liverpool-Bootle district using the H + 1 assessment as the basis. The local fire officers with their special experience of the fire risks in their areas, allocated the positions and determined where the fire spread was most likely to take place. This work, which was most painstakingly carried out resulted in the production of the four fire situation maps which you see here displayed.

XIX DR. PURCELL: I should like to say how much we have appreciated the help of the Scientific Advisers during the past year. Additionally I know that you will not wish to close without allowing me to say to the Commandant of the Staff College how much we appreciate the kindness and hospitality that we have received during this Conference. We particularly appreciate his magical touch with the weather; the sun always shines when we come here. Thank you very much indeed.




$B = 1.24\,(1 - e^{-g})$ radians

$g = 0.4\,(t/T)^{2.4}$

t = time

T = time when reflected shock reaches bottom of fireball, flattening it into a truncated sphere

( Maximum allowed value of B = 71 degrees )

John R. Keith and Anthony F. Portare, An Analysis of Army Thermal Transmissivity Calculations, Kaman Sciences Corp., Arlington, VA., report DNA-TR-84-388 (1984)


Top of fireball is cooled by water entrainment;
bottom is blocked by city skyline (or clouds) duh
NORMAL
CLOUDS
BRAVO (15 megatons or 22 megatons) seen not
from an aircraft above cloud cover, but from
surface level: clouds block hot base of fireball!

*Fireball shielding by clouds (and people), 1.37 Mt Koa, 1958*


Семипалатинский
полигон
1956 г.
40 кт
38 kt at 340 m altitude, 10 September 1956 Russian test